

# Multigrid preconditioner for the Helmholtz equation based on a new discretization with complex coefficients

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The Helmholtz equation is widely used as model problem in fields where indefinite partial differential equations play a role. Effective preconditioners are in demand, and yet this remains a challenging task for high wavenumber problems. In this work, we employ a multigrid preconditioner based on a new finite-difference discretization, which employs complex coefficients and yet remains Hermitian. The approach builds upon a recent development by Haber and Maclachlan (J. Comp. Phys., 2011), who employ a reformulation of the Helmholtz problem into a complex advection-diffusion-reaction equation. By applying an inverse transformation to the discretized Haber-MacLachlan operator, we obtain the new discretization of the original Helmholtz problem, which serves as a preconditioner in our work. This preconditioner brings several advantages, as demonstrated analytically and numerically.